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ABSTRACT

Most students, perhaps over 90 percent, can master what teachers have to teach them, and it is the task of instruction to find the means which will enable students to master the subject under consideration. A basic task is to determine what is meant by mastery of the subject and to search for methods and materials which will enable the largest proportion of students to attain such mastery. That is, the basic task in education is to find strategies which will take individual differences into consideration but in such a way as to promote the fullest development of the individual. The thesis of this paper is that, to promote mastery learning, 5 variables must be dealt with effectively: (1) aptitude for kinds of learning, viewed as the amount of time required by the learner to attain mastery of the task; (2) quality of instruction, viewed in terms of its approaching the optimum for a given learner; (3) ability to understand instruction, i.e., to understand the nature of the task and the procedures to follow; (4) perseverance, the amount of time one is willing to spend in learning; and (5) time allowed for learning, the key to mastery. (Author/TA)

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Instruction and Curriculum

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TOPICAL PAPERS AND REPRINTS NO. 1

LEARNING FOR MASTERY

BENJAMIN S. BLOOM

Each teacher begins a new term (or course) with the expectation that about a third of his students will adequately learn what he has to teach. He expects about a third of his students to fail or to just "get by." Finally, he expects another third to learn a good deal of what he has to teach, but not enough to be regarded as "good students." This set of expectations, supported by school policies and practices in grading, becomes transmitted to the students through the grading procedures and through the methods and materials of instruction. The system creates a self-fulfilling prophecy such that the final sorting of students through the grading process becomes approximately equivalent to the original expectations.

This set of expectations, which fixes the academic goals of teachers and students, is the most wasteful and destructive aspect of the present educational system. It reduces the aspirations of both teachers and students; it reduces motivation for learning in students; and it systematically destroys the ego and self-concept of a sizable group of students who are legally required to attend school for 10 to 12 years under conditions which are frustrating and humiliating year after year. The cost of this system in reducing opportunities for further learning and in alienating youth from both school and society is so great that no society can tolerate it for long.

Most students (perhaps over 90 percent) can master what we have to teach them, and it is the task of instruction to find the means which will enable our students to master the subject under consideration. Our basic task is to determine what we mean by mastery of the subject and to search for the methods and materials which will enable the largest proportion of our students to attain such mastery.

In this paper we will consider one approach to learning for mastery and the underlying theoretical concepts, research findings, and techniques required. Basically, the problem of developing a strategy for mastery learning is one of determining how individual differences in learners can be related to the learning and teaching process.

BACKGROUND

Some societies can utilize only a small number of highly educated persons in the economy and can provide the economic support for only a small proportion of the students to complete secondary or higher education. Under such conditions much of the effort of the schools and the external examining system is to find ways of rejecting the majority of students at various points in the educational system and to discover the talented few who are to be given advanced educational opportunities. Such societies invest a great deal more in the prediction and selection of talent than in the development of such talent.

The complexities of the skills required by the work force in the United States and in other highly developed nations means that we can no longer operate on the assumption that completion of secondary and advanced education is for the few. The increasing evidence, Schultz (1963) and Bowman (1966), that investment in the education of humans pays off at a greater rate than does capital investment suggests that we cannot return to an economy of scarcity of educational opportunity.

Whatever might have been the case previously, highly developed nations must seek to find ways to increase the proportion of the age group that can successfully complete both secondary and higher education. The problem is no longer one of

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finding the few who can succeed. The basic problem is to determine how the largest proportion of the age group can learn effectively those skills and subject matter regarded as essential for their own development in a complex society.

However, given another set of philosophic and psychological presuppositions, we may express our concern for the intellectual and personality consequences of lack of clear success in the learning tasks of the school. Increasingly, learning throughout life (continuing learning) will be necessary for the largest proportion of the work force. If school learning is regarded as frustrating and even impossible by a sizable proportion of students, then little can be done at later levels to kindle a genuine interest in further learning. School learning must be successful and rewarding as one basis for insuring that learning can continue throughout one's life as needed.

Even more important in modern society is the malaise about values. As the secular society becomes more and more central, the values remaining for the individual have to do with hedonism, interpersonal relations, self-development, and ideas. If the schools frustrate the students in the latter two areas, only the first two are available to the individual. Whatever the case may be for each of these values, the schools must strive to assure all students of successful learning experiences in the realm of ideas and self-development.

There is little question that the schools now do provide successful learning experiences for some students—perhaps as high as one third of the students. If the schools are to provide successful and satisfying learning experiences for at least 90 percent of the students, major changes must take place in the attitudes of students, teachers, and administrators; changes must also take place in teaching strategies and in the role of evaluation.

THE NORMAL CURVE

We have for so long used the normal curve in grading students that we have come to believe in it. Our achievement measures are designed to detect diff rences among our learners, even if the differences are trivial in terms of the subject matter. We then distribute our grades in a normal fashion. In any group of students we expect to have some small percent receive A grades. We are surprised when the percentage differs greatly from about 10 percent. We are also prepared to fail an equal proportion of students. Quite frequently this failure is determined by the rank order of the students in the group rather than by their failure to grasp the essential ideas of the course. Thus, we have become accustomed to classify students into about five categories of level of performance and to assign grades in some relative fashion. It matters not that the failures of one year performed at about the same level as the C students of another year. Nor does it matter that the A students of one school do about as well as the F students of another school.

Having become "conditioned" to the normal distribution, we set grade policies in these terms and are horrified when some teacher attempts to recommend a very different distribution of grades. Administrators are constantly on the alert to control teachers who are "too easy" or "too hard" in their grading. A teacher whose grade distribution is normal will avoid difficulties with administrators. But even more important, we find ways of convincing students that they can only do C work or D work by our grading system and even by our system of quiz and progress testing. Finally, we proceed in our teaching as though only the minority of our students should be able to learn what we have to teach.

There is nothing sacred about the normal curve. It is the distribution most appropriate to chance and random activity. Education is a purposeful activity and we seek to have the students learn what we have to teach. If we are effective in our instruction, the distribution of achievement should be very different from the normal curve. In fact, we may even insist that our educational efforts have been *unsuccessful* to the extent to which our distribution of achievement approximates the normal distribution.

"Individual differences" in learners is a fact that can be demonstrated in many ways. That our students vary in many ways can never be forgotten. That these variations must be reflected in learning standards and achievement criteria is more a reflection of our policies and practices rather than the necessities of the case. Our basic task in education is to find strategies which will take individual differences into consideration but which will do so in such a way as to promote the fullest development of the individual.

THE VARIABLES FOR MASTERY LEARNING STRATEGIES

A learning strategy for mastery may be derived from the work of Carroll (1963), supported by the ideas of Morrison (1926), Bruner (1966), Skinner (1954), Suppes (1966), Goodlad and Anderson (1959), and Glaser (1968). In presenting these ideas we will refer to some of the research findings which bear on them. However, our main concern here is with the major variables in a model of school learning and the ways in which these variables may be utilized in a strategy for mastery learning.

Put in its most brief form the model proposed by Carroll (1963) makes it clear that if the students are normally distributed with respect to *aptitude* for some subject (mathematics, science, literature, history, etc.) and all the students are provided with exactly the *same instruction* (same in terms of amount of instruction, quality of instruction, and time

available for learning), the end result will be a normal distribution on an appropriate measure of achievement. Furthermore, the relationship between aptitude and achievement will be relatively high (correlations of + .70 or higher are to be expected if the aptitude and achievement measures are valid and reliable). Conversely, if the students are normally distributed with respect to aptitude, but the kind and quality of instruction and the amount of time available for learning are made appropriate to the characteristics and needs of *each* student, the majority of students may be expected to achieve mastery of the subject. And, the relationship between aptitude and achievement should approach zero. It is this basic set of ideas we wish to develop in the following.

1. Aptitude for Particular Kinds of Learning

We have come to recognize that individuals do differ in their aptitudes for particular kinds of learning and over the years we have developed a large number of aptitude tests to measure these differences. In study after study we have found that aptitude tests are relatively good predictors of achievement criteria (achievement tests or teacher judgments). Thus, a good set of mathematic aptitude tests given at the beginning of the year will correlate as high as +.70 with the mathematics achievement tests given at the end of the course in algebra, or some other mathematics subject.

The use of aptitude tests for predictive purposes and the high correlations between such tests and achievement criteria have led many of us to the view that high levels of achievement are possible only for the most able students. From this, it is an easy step to some notion of a causal connection between aptitude and achievement. The simplest notion of causality is that the students with high levels of aptitude can learn the complex ideas of the subject while the students with low levels of aptitude can learn only the simplest ideas of the subject.

Quite in contrast to this is Carroll's (1963) view that *aptitude is the amount of time required by the learner to attain mastery of a learning task.* Implicit in this formulation is the assumption that, given enough time, all students can conceivably attain mastery of a learning task. If Carroll is right, then learning mastery is theoretically available to all, if we can find the means for helping each student. It is this writer's belief that this formulation of Carroll's has the most fundamental implications for education.

One type of support for this view is to be found in the grade norms for many standardized achievement tests. These norms demonstrate that selected criterion scores achieved by the top students at one grade level are achieved by the majority of students at a later grade level. Further support is available in studies where students can learn at their own rate. These studies show that although most students eventually reach mastery on each learning task, some students achieve mastery much sooner than do other students (Glaser, 1968; Atkinson, 1967).

Can all students learn a subject equally well? That is, can all students master a learning task at a high level of complexity? As we study aptitude distributions in relation to student performance we have become convinced that there are differences between the extreme students and the remainder of the population. At the top of the aptitude distribution (1 percent to 5 percent) there are likely to be some students who have a special talent for the subject. Such students are able to learn and to use the subject with greater fluency than other students. The student with special aptitudes for music or foreign languages can learn these subjects in ways not available to most other students. Whether this is a matter of native endowment or the effect of previous training is not clear, although this must vary from subject to subject. It is likely that some individuals are born with sensory organs better attuned to sounds (music, language, etc.) than are others and that these constitutional characteristics give them special advantages in learning such subjects over others. For other subjects, special training, particular interests, etc., may develop these high level aptitudes.

At the other extreme of the aptitude distribution, we believe there are individuals with special disabilities for particular learning. The tone deaf individual will have great difficulty in learning music; the color blind individual will have special problems in learning art; the individual who thinks in concrete forms will have special problems in learning highly abstract conceptual systems such as philosophy. Again, we believe these may constitute less than 5 percent of the distribution, but this will vary with the subject and the aptitudes.

In between are approximately 90 percent of the individuals where we believe (as does Carroll) that aptitudes are predictive of rate of learning rather than the level (or complexity) of learning that is possible. Thus, we are expressing the view that, given sufficient time (and appropriate types of help), 95 percent of students (the top 5 percent + the next 90 percent) can learn a subject up to a high level of mastery. We are convinced that the grade of A as an index of mastery of a subject can, under appropriate conditions, be achieved by up to 95 percent of the students in a class.

It is assumed that it will take some students more effort, time, and help to achieve this level than it will other students. For some students the effort and help required may make it prohibitive. Thus, to learn high school algebra to a point of mastery may require several years for some students but only a fraction of a year

for other students. Whether mastery learning is worth this great effort for the students who may take several years is highly questionable. One basic problem for a mastery learning strategy is to find ways of reducing the amount of time required for the slower students to a point where it is no longer a prohibitively long and difficult task for these less able students.

We do not believe that aptitude for particular learning tasks is completely stable. There is evidence (Bloom, 1964; Hunt, 1961) that the aptitude for particular learning tasks may be modified by appropriate environmental conditions or learning experiences in the school and the home. The major task of educational programs concerned with learning to learn and general education should be to produce positive changes in the students' basic aptitudes. It is likely that these aptitudes can be most markedly affected during the early years in the home and during the elementary years of school. Undoubtedly, however, some changes can take place at later points in the individual's career.

However, even if marked changes are not made in the individual's aptitudes, it is highly probable that more effective learning conditions can reduce the amount of time required to learn a subject to mastery for all students and especially for the students with lower aptitudes. It is this problem which must be directly attacked by strategies for mastery learning.

2. Quality of Instruction

Our schools have usually proceeded on the assumption that there is a standard classroom situation for all students. Typically, this has been expressed in the teacher-student ratio of 1-30 with group instruction as the central means of teaching. There is the expectation that each teacher will teach the subject in much the same way as other teachers. This standardization is further emphasized by textbook adoption which specifies the instructional material to be provided each class. Closely related to this is the extensive research over the past 50 years which seeks to find the one instructional method, material, or curriculum program that is best for all students.

Thus, over the years, we have fallen into the "educational trap" of specifying quality of instruction in terms of good and poor teachers, teaching, instructional materials, curriculum—all in terms of group results. We persist in asking such questions as: What is the best teacher for the group? What is the best method of instruction for the group? What is the best instructional material for the group?

One may start with the very different assumption that individual students may need very different types and qualities of instruction to achieve mastery. That is, the same content and objectives of instruction may be learned by different students as the result of very different types of instruction. Carroll (1963) defines the *quality of instruction in terms of the degree to which the presentation, explanation, and ordering of elements of the task to be learned approach the optimum for a given learner.*

Much research is needed to determine how individual differences in learners can be related to variations in the quality of instruction. There is evidence that some students can learn quite well through independent learning efforts while others need highly structured teaching-learning situations (Congreve, 1965). It seems reasonable to expect that some students will need more concrete illustrations and explanations than will others; some students may need more examples to get an idea than do others; some students may need more approval and reinforcement than others; and some students may even need to have several repetitions of the explanation while others may be able to get it the first time.

We believe that if every student had a very good tutor, most of them would be able to learn a particular subject to a high degree. A good tutor attempts to find the qualities of instruction (and motivation) best suited to a given learner. And, there is some evidence (Dave, 1963) that middle-class parents do attempt to tutor their children when they believe that the quality of instruction in school does not enable their children to learn a particular subject. In an unpublished study, the writer found that one third of the students in an algebra course in a middle-class school were receiving as much tutorial instruction in the home in algebra as they were receiving group instruction in the school. These students received relatively high grades for the algebra course. For these students, the relationship between their mathematics aptitude scores (at the beginning of the year) and their achievement in algebra at the end of the year was almost zero. In contrast, for the students who received no additional instruction other than the regular classroom instruction, the relationship between their mathematics aptitude scores and their algebra achievement scores was very high (+.90). While this type of research needs to be replicated, it is evident in this small study that the home tutoring help was providing the quality of instruction needed by these students to learn the algebra—that is, the instruction was adapted to the needs of the individual learners.

The main point to be stressed is that the quality of instruction is to be considered in terms of its effects on individual learners rather than on random groups of learners. Hopefully, the research of the future may lead to the definition of the qualities and kinds of instruction needed by various *types* of learners. Such research may suggest more effective group instruction since it is unlikely that the schools will be able to provide instruction for each learner separately.

3. Ability to Understand Instruction

In most courses at the high school and college level there is a single teacher and a single set of instructional materials. If the student has facility in understanding the teacher's communications about the learning and the instructional material (usually a textbook), he has little difficulty in learning the subject. If he has difficulty in understanding the teacher's instruction and/or the instructional material, he is likely to have great difficulty in learning the subject. *The ability to understand instruction may be defined as the ability of the learner to understand the nature of the task he is to learn and the procedures he is to follow in the learning of the task.*

Here is a point at which the student's abilities interact with the instructional materials and the instructor's abilities in teaching. For the student in our highly verbal schools it is likely that this ability to understand instruction is primarily determined by verbal ability and reading comprehension. These two measures of language ability are significantly related to achievement in the majority of subjects and they are highly related (+.50 to +.60) to grade point averages at the high school or college level. What this suggests is that verbal ability (independent of specific aptitudes for each subject) determines some general ability to learn from teachers and instructional materials.

While it is possible to alter an individual's verbal ability by appropriate training, there are limits to the amount of change that can be produced. Most change in verbal ability can be produced at the preschool and elementary school levels with less and less change being likely as the student gets older (Bloom, 1964). Vocabulary and reading ability, however, may be improved to some extent at all age levels, even though there is a diminishing utility of this approach with increasing age. Improvements in verbal abilities should result in improvements in the individual's ability to understand instruction.

The greatest immediate payoff in dealing with the ability to understand instruction is likely to come from modifications in instruction in order to meet the needs of individual students. There is no doubt that some teachers do attempt to modify their instruction to fit a given group of students. Many teachers center their instruction at the middle group of their students, others at the top or bottom group—these are, however, reflections of the teacher's habits and attitudes. They are, by no means, determinants of what it is *possible* for a teacher to do. Given help and various types of aids, individual teachers can find ways of modifying their instruction to fit the differing needs of their students.

Group study procedures should be available to students as they need it. In our own experience we have found that small groups of students (two or three students) meeting regularly to go over points of difficulty in the learning process were most effective, especially when the students could cooperate and help each other without any danger of giving each other special advantages in a competitive situation. Where learning can be turned into a cooperative process with everyone likely to gain from the process, small group learning procedures can be very effective. Much depends on the composition of the group and the opportunities it gives each person to expose his difficulties and have them corrected without demeaning one person and elevating another. In the group process, the more able students have opportunities to strengthen their own learning in the process of helping another person grasp the idea through alternative ways of explaining and using the idea.

Tutorial help (one to one relations between teacher and learner) represents the most costly type of help and should be used only where alternative procedures are not effective. However, this type of help should be available to students as they need it, especially where individuals have particular difficulties that can't be corrected in other ways. The tutor, ideally, should be someone other than the teacher, since he should bring a fresh way of viewing the idea or the process. The tutor must be skillful in detecting the points of difficulty in the student's learning and should help him in such a way as to free the student from continued dependence on him.

Another approach to variations in the students' ability to understand instruction is to vary the instructional material.

Textbooks may vary in the clarity with which they explain a particular idea or process. The fact that one textbook has been adopted by the school or by the teacher does not necessarily mean that other textbooks cannot be used at particular points in the instruction when they would be helpful to a student who can't grasp the idea from the adopted textbook. The task here is to be able to determine where the individual student has difficulty in understanding the instructions and then provide alternative textbook explanations if they are more effective at that point.

Workbooks and programmed instruction units may be especially helpful for some students who cannot grasp the ideas or procedures in the textbook form. Some students need the drill and the specific tasks which workbooks can provide. Other students need the small steps and frequent reinforcement which programmed units can provide. Such materials may be used in the initial instruction or as students encounter specific difficulties in learning a particular unit or section of the course.

Audiovisual Methods and Academic Games. Some students may

learn a particular idea best through concrete illustrations and vivid and clear explanations. It is likely that film strips and short motion pictures which can be used by individual students as needed may be very effective. Other students may need concrete material such as laboratory experiences, simple demonstrations, blocks and other relevant apparatus in order to comprehend an idea or task. Academic games, puzzles, and other interesting but not threatening devices may be useful. Here again, the point is that some ways of communicating and comprehending an idea, problem, or task may be especially effective for some students although others may not use or need such materials and methods. We need not place the highest priority for all on abstract and verbal ways of instruction.

With regard to instructional materials, the suggestion is not that particular materials be used by particular students throughout the course. It is that each type of material may serve as a means of helping individual students at selected points in the learning process—and that a particular student may use whatever variety of materials are found to be useful as he encounters difficulties in the learning.

Throughout the use of alternative methods of instruction and instructional material, the essential point to be borne in mind is that these are attempts to improve the *quality of instruction* in relation to the ability of each student to *understand the instruction*. As feedback methods inform the teachers of particular errors and difficulties the majority of students are having, it is to be expected that the regular group instruction could be modified so as to correct these difficulties. As particular students are helped individually, the goal should be not only to help the student over particular learning difficulties but also to enable him to become more independent in his learning and to help him identify the alternative ways by which he can comprehend new ideas. But, most important, the presence of a great variety of instructional materials and procedures should help both teachers and students to overcome feelings of defeatism and passivity about learning. If the student can't learn in one way, he should be reassured that alternatives are available to him. The teacher should come to recognize that it is the learning which is important and that instructional alternatives exist to enable all (or almost all) of the students to learn the subject to a high level.

4. Perseverance

Carroll defines *perseverance as the time the learner is willing to spend in learning*. If a student needs to spend a certain amount of time to master a particular task, and he spends less than this amount in active learning, he is not likely to learn the task to the level of mastery. Carroll attempts to differentiate between spending time on learning and the amount of time the student is actively engaged in learning.

Perseverance does appear to be related to attitudes toward and interest in learning. In the International Study of Educational Achievement (Husén, 1967), the relationship between the number of hours of homework per week reported by the student (a crude index of perseverance) and the number of years of further education desired by the student is +.25.

We do believe that students vary in the amount of perseverance they bring to a specific learning task. However, students appear to approach different learning tasks with different amounts of perseverance. The student who gives up quickly in his efforts to learn an academic subject may persevere an unusually long time in learning how to repair an automobile or in learning to play a musical instrument. It would appear to us that as a student finds the effort rewarding, he is likely to spend more time on a particular learning task. If, on the other hand, the student is frustrated in his learning, he must (in self-defense) reduce the amount of time he devotes to learning. While the frustration level of students may vary, we believe that all students must sooner or later give up a task if it is too painful for them.

While efforts may be made to increase the amount of perseverance in students, it is likely that manipulation of the instruction and learning materials may be more effective in helping students master a given learning task, in spite of their present level of perseverance. Frequency of reward and evidence of success in learning can increase the student's perseverance in a learning situation. As students attain mastery of a given task, they are likely to increase their perseverance for a related learning task.

In our own research we are finding that the demands for perseverance may be sharply reduced if students are provided with instructional resources most appropriate for them. Frequent feedback accompanied by specific help in instruction and material as needed can reduce the time (and perseverance) required. Improvement in the quality of instruction (or explanations and illustrations) may reduce the amount of perseverance necessary for a given learning task.

There seems to be little reason to make learning so difficult that only a small proportion of the students can persevere to mastery. Endurance and unusual perseverance may be appropriate for long-distance running—they are not great virtues in their own right. The emphasis should be on learning, not on vague ideas of discipline and endurance.

5. Time Allowed for Learning

Throughout the world schools are organized to give group instruction

with definite periods of time allocated for particular learning tasks. A course in history at the secondary level may be planned for an academic year of instruction, another course may be planned for a semester, while the amount of instructional time allocated for a subject like arithmetic at the 5th-grade level may be fixed. Whatever the amount of time allowed by the school and the curriculum for particular subjects or learning tasks, it is likely to be too much for some students and not enough for other students.

For Carroll, the time spent on learning is the key to mastery. His basic assumption is that aptitude determines the rate of learning and that most, if not all, students can achieve mastery if they devote the amount of time needed to the learning. This implies that the student must not only devote the amount of time he needs to the learning task but also that he be *allowed* enough time for the learning to take place.

There seems to be little doubt that students with high levels of aptitude are likely to be more efficient in their learning and to require less time for learning than students with lower levels of aptitude. Whether most students can be helped to become highly efficient learners in general is a problem for future research.

The amount of time students need for a particular kind of learning has not been studied directly. One indication of the time needed comes from studies of the amount of time students spend on homework. In our review of the amount of time spent by 13-year-old students on mathematics homework in the International Study of Educational Achievement (Husén, 1967), we find that if we omit the extreme 5 percent of the subjects, the ratio is roughly 6 to 1. That is, some students spend 6 times as much time on mathematics homework as do others. Other studies of use of time suggest that this is roughly the order of magnitude to be expected.

If instruction and student use of time become more effective, we believe that most students will need less time to learn the subject to mastery and that the ratio of time required for the slower and the faster learners may be reduced from about 6 to 1 to perhaps 3 to 1.

In general, we find a zero or a slightly negative relationship between final grades and amount of time spent on homework. In the International Study (Husén, 1967) the average correlation for twelve countries at the 13-year-old level is approximately −.05 between achievement test scores in mathematics and number of hours per week of homework in mathematics as reported by students. Thus, the amount of time spent on homework does not seem to be a very good predictor of achievement in the subject.

We are convinced that it is not the sheer amount of time spent in learning (either in school or out of school) that accounts for the level of learning. We believe that each student should be allowed the time he needs to learn a subject. And, the time he needs to learn the subject is likely to be affected by the student's aptitudes, his verbal ability, the quality of instruction he receives in class, and the quality of the help he receives outside of class. The task of a strategy for mastery learning is to find ways of altering the time individual students need for learning as well as to find ways of providing whatever time is needed by each student. Thus, a strategy for mastery learning must find some way of solving the instructional problems as well as the school organizational (including time) problems.

ONE STRATEGY FOR MASTERY LEARNING

There are many alternative strategies for mastery learning. Each strategy must find some way of dealing with individual differences in learners through some means of relating the instruction to the needs and characteristics of the learners. We believe that each strategy must include some way of dealing with the five variables discussed in the foregoing.

Were it not so costly in human resources, we believe that the provision of a good tutor for each student might be one ideal strategy. In any case, the tutor-student relationship is a useful model to consider when one attempts to work out the details of a less costly strategy. Also, the tutor strategy is not as farfetched as it may seem at first glance. In the preschool period most of the child's instruction is tutorial—usually provided by the mother. In many middle class homes the parents continue to provide tutorial help as needed by the child during much of his school career.

Other strategies include permitting students to go at their own pace, guiding students with respect to courses they should or should not take, and providing different tracks or streams for different groups of learners. The nongraded school (Goodlad and Anderson, 1959) is one attempt to provide an organizational structure that permits and encourages mastery learning.

A group of us at the University of Chicago have been doing research on the variables discussed in the previous pages. In addition, some of us have been attempting to develop a strategy of teaching and learning which will bring all (or almost all) students to a level of mastery in the learning of any subject. Our approach has been to supplement regular group instruction by using diagnostic procedures and alternative instructional methods and materials in such a way as to bring a large proportion of the students to a predetermined standard of achievement. In this approach, we have tried to bring most of the students to mastery levels of achievement within the regular term, semester, or period of calendar time in which the course is

usually taught. Undoubtedly, some students will spend more time than others in learning the subject, but if the majority of students reach mastery levels at the end of the time allocated for the subject, mastery will have affective as well as cognitive consequences.

We have had some successes and some dismal failures with this approach. We have been trying to learn from both the successes and the failures. In the near future we hope to have some of these ideas applied to a large number of classrooms in selected school systems. Initially, we have chosen to work with subjects which have few prerequisites (algebra, science, etc.) because we believe it is easier to secure mastery learning in a given time period in such courses. In contrast are subjects which are late in a long sequence of learning (6th grade reading, 8th grade arithmetic, advanced mathematics, etc.). For such subjects, it is unlikely that mastery learning can be attained within a term for a group of students who have had a long history of cumulative learning difficulties in the specific subject field.

In working on this strategy we have attempted to spell out some of the *preconditions* necessary, develop the *operating procedures* required, and evaluate some of the *outcomes* of the strategy.

Preconditions

If we are able to develop mastery learning in students, we must be able to recognize when students have achieved it. We must be able to define what we mean by mastery and we must be able to collect the necessary evidence to establish whether or not a student has achieved it.

The specification of the objectives and content of instruction is one necessary precondition for informing both teachers and students about the expectations. The translation of the specifications into evaluation procedures helps to further define what it is that the student should be able to do when he has completed the course. The evaluation procedures used to appraise the outcomes of instruction (summative evaluation) help the teacher and student know when the instruction has been effective.

Implicit in this way of defining the outcomes and preparing evaluation instruments is a distinction between the teaching-learning process and the evaluation process. At some point in time, the results of teaching and learning can be reflected in the evaluation of the students. But, these are *separate* processes. That is, teaching and learning are intended to prepare the student in an area of learning, while evaluation (summative) is intended to appraise the extent to which the student has developed in the desired ways. Both the teacher and the learner must have some understanding of what the achievement criteria are and both must be able to secure evidence of progress toward these criteria.

If the achievement criteria are primarily competitive, i.e., the student is to be judged in terms of his relative position in the group, then the student is likely to seek evidence on his standing in the group as he progresses through the learning tasks. We recognize that competition may be a spur to those students who view others in competitive terms, but we believe that much of learning and development may be destroyed by primary emphasis on competition.

Much more preferable in terms of intrinsic motivation for learning is the setting of standards of mastery and excellence apart from interstudent competition, followed by appropriate efforts to bring as many students up to this standard as possible. This suggests some notion of absolute standards and the use of grades or marks which will reflect these standards. Thus, it is conceivable that all students may achieve mastery and the grade of A. It is also possible in a particular year in a specific course for few or none of the students to attain mastery or a grade of A.

While we would recommend the use of absolute standards carefully worked out for a subject, we recognize the difficulty of arriving at such standards. In some of our own work, we have made use of standards derived from previous experience with students in a particular course. In one course, students in 1966 were informed that the grades for 1966 would be based on *standards* arrived at in 1965. The grades of A, B, C, D, and F would be based on an examination which was parallel to that used in 1965 and the grades would be set at the same performance levels as those used in 1965. The students were informed that the proportion of students receiving each grade was to be determined by their performance levels rather than by their rank order in the group. Thus, the students were not competing with each other for grades; they were to be judged on the basis of levels of mastery used in 1965.

We do not believe this is the only way of arriving at achievement standards, but the point is that students must feel they are being judged in terms of level of performance rather than a normal curve or some other arbitrary and relative set of standards. We are not recommending national achievement standards. What is being recommended are realistic performance standards developed for each school or group, followed by instructional procedures which will enable the majority of students to attain these standards.

One result of this way of setting achievement standards was to enable the students to work with each other and to help each other without being concerned about giving special advantages (or disadvantages) to other students. Cooperation in learning rather than competition was a clear result from this method of setting achievement criteria.

In the work we have done, we at-

tempted to have the teacher teach the course in much the same way as previously. That is, the particular materials and methods of instruction in the current year should be about the same as in previous years. Also, the time schedule during the course was about the same. The operating procedures discussed in the next section *supplemented* the regular instruction of the teacher. We have proceeded in this way because we believe a useful strategy for mastery learning should be widely applicable. If extensive training of teachers is necessary for a particular strategy, it is less likely that it will receive widespread use.

Operating Procedures

The operating procedures we have used are intended to provide detailed feedback to teachers and students and to provide specific supplementary instructional resources as needed. These procedures are devised to insure mastery of each learning unit in such a way as to reduce the time required while directly affecting both quality of instruction and the ability of the student to understand the instruction.

Formulative Evaluation. One useful operating procedure is to break a course or subject into smaller units of learning. Such a learning unit may correspond to a chapter in a textbook, a well-defined content portion of a course, or a particular time unit of the course. We have tended to think of units as involving a week or two of learning activity.

Using some of the ideas of Gagné (1965) and Bloom (1956) we have attempted to analyze each unit into a number of elements ranging from specific terms or facts, more complex and abstract ideas such as concepts and principles, and relatively complex processes such as application of principles and analysis of complex theoretical statements. We believe, as does Gagné (1965) that these elements form a hierarchy of learning tasks.

We have then attempted to construct brief diagnostic-progress tests which can be used to determine whether or not the student has mastered the unit and what, if anything, the student must still do to master it. We have borrowed the term *Formative Evaluation* from Scriven (1967) to refer to these diagnostic-progress tests.

Frequent formative evaluation tests pace the learning of students and help motivate them to put forth the necessary effort at the appropriate time. The appropriate use of these tests helps to insure that each set of learning tasks is thoroughly mastered before subsequent learning tasks are started.

Each formative test is administered after the completion of the appropriate learning unit. While the frequency of these progress tests may vary throughout the course, it is likely that some portions of the course—especially the early sections of the course—may need more frequent formative tests than later portions. Where some of the learning units are basic and prerequisite for other units of the course, the tests should be frequent enough to insure thorough mastery of such learning material.

For those students who have thoroughly mastered the unit, the formative tests should reinforce the learning and assure the student that his present mode of learning and approach to study is adequate. Since he will have a number of such tests, the student who consistently demonstrates mastery should be able to reduce his anxiety about his course achievement.

For students who lack mastery of a particular unit, the formative tests should reveal the particular points of difficulty—the specific questions they answer incorrectly and the particular ideas, skills, and processes they still need to work on. It is most helpful when the diagnosis shows the elements in a learning hierarchy that the student still needs to learn. We have found that students respond best to the diagnostic results when they are referred to particular instructional materials or processes intended to help them correct their difficulties. The *diagnosis* should be accompanied by a very specific *prescription* if the students are to do anything about it.

Although we have limited evidence on this point, we believe that the formative tests should not be assigned grades or quality points. We have marked the tests to show *mastery* and *nonmastery*. The nonmastery is accompanied by detailed diagnosis and prescription of what is yet to be done before mastery is complete. We believe that the use of grades on repeated progress tests prepares students for the acceptance of less than mastery. To be graded C repeatedly, prepares the student to accept a C as his "fate" for the particular course, especially when the grades on progress tests are averaged in as part of the final grade. Under such conditions, there must come a point when it is impossible to do better than a particular grade in the course—and there is little value in striving to improve. Formative evaluation tests should be regarded as part of the learning process and should in no way be confused with the judgment of the capabilities of the student or used as a part of the grading process.

These formative tests may also provide feedback for the teacher since they can be used to identify particular points in the instruction that are in need of modification. The formative evaluation tests also can serve as a means of quality control in future cycles of the course. The performance of the students on each test may be compared with the norms for previous years to insure that students are doing as well or better. Such comparisons can also be used to insure that changes in instruction or materials are not producing more error and difficulty

than was true in a previous cycle of the course.

Alternative Learning Resources. It is one thing to diagnose the specific learning difficulties the student has and to suggest the specific steps he should take to overcome these difficulties. It is quite another thing to get him to do anything about it. By itself, the frequent use of progress tests can improve the achievement of students to a small degree. If, in addition, the student can be motivated to expend further effort on correcting his errors on the progress tests, the gains in achievement can be very great.

We have found that students do attempt to work on their difficulties when they are given specific suggestions (usually on the formative evaluation results) as to what they need to do.

The best procedure we have found thus far is to have small groups of students (two or three) meet regularly for as much as an hour per week to review the results of their formative evaluation tests and to help each other overcome the difficulties identified on these tests.

We have offered tutorial help as students desired it, but so far students at the secondary or higher education level do not seek this type of help frequently.

Other types of learning resources we have prescribed for students include: a. reread particular pages of the original instructional materials; b. read or study specific pages in alternative textbooks or other instructional materials; c. use specific pages of workbooks or programmed texts; and d. use selected audio-visual materials.

We suspect that no specific learning material or process is indispensable. The presence of a great variety of instructional materials and procedures and specific suggestions as to which ones the student might use help the student recognize that if he cannot learn in one way, alternatives are available to him. Perhaps further research will reveal the best match between individuals and alternative learning resources. At present, we do not have firm evidence on the relations between student characteristics and instructional materials and procedures.

Outcomes

What are the results of a strategy for mastery learning? So far we have limited evidence. The results to date, however, are very encouraging. We are in the process of securing more evidence on a variety of situations at the elementary, secondary, and higher education levels.

Cognitive Outcomes of a Mastery Strategy. In our work to date we have found some evidence of the effectiveness of a strategy for mastery learning. Our best results have been found in a course on test theory where we have been able to use parallel achievement tests for the course in 1965, 1966, and 1967. In 1965, before the strategy was used, approximately 20 percent of the students received the grade of A on the final examination. In 1966, after the strategy was employed, 80 percent of the students reached this same level of mastery on the parallel examination and were given the grade of A. The difference in the mean performance of the two groups represents about two standard deviations on the 1965 achievement test and is highly significant.

In 1967, using the same formative evaluation tests as used in 1966, it was possible to compare the 1966 and the 1967 results after each unit of learning. Thus, the formative evaluation tests became quality control measures. Where there were significant negative differences between the results on a particular test from 1966 to 1967, the instructor reviewed the specific learning difficulties and attempted to explain the ideas in a different way. The final results on the 1967 summative evaluation instrument, which was parallel to the final achievement tests in 1965 and 1966, were that 90 percent of the students achieved mastery and were given grades of A.

Similar studies are under way at different levels of education. We expect to have many failures and a few successes. But, the point to be made is not that a single strategy of mastery learning can be used mechanically to achieve a particular set of results. Rather, the problem is one of determining what procedures will prove effective in helping particular students learn the subject under consideration. It is hoped that each time a strategy is used, it will be studied to find where it is succeeding and where it is not. For which students is it effective and for which students is it not effective? Hopefully, the results in a particular year can take advantage of the experience accumulated over the previous years.

Affective Consequences of Mastery. We have for the past century conceived of mastery of a subject as being possible for only a minority of students. With this assumption we have adjusted our grading system so as to certify that only a small percent of students (no matter how carefully selected) are awarded a grade of A. If a group of students learns a subject in a superior way (as contrasted with a previous group of students) we still persist in awarding the A (or mastery) to only the top 10 or 15 percent of the students. We grudgingly recognize that the majority of students have "gotten by" by awarding them grades of D or C. Mastery and recognition of mastery under the present relative grading system is unattainable for the majority of students—but this is the result of the way in which we have "rigged" the educational system.

Mastery must be both a subjective recognition by the student of his competence and a public recognition by the school or society. The public recognition must be in the form of appropriate certification by the teacher or by the school. No matter

how much the student has learned, if public recognition is denied him, he must come to believe that he is inadequate, rather than the system of grading or instruction. Subjectively, the student must gain feelings of control over ideas and skills. He must come to recognize that he "knows" and can do what the subject requires.

If the system of formative evaluation (diagnostic-progress tests) and the summative evaluation (achievement examinations) informs the student of his mastery of the subject, he will come to believe in his own mastery and competence. He may be informed by the grading system as well as by the discovery that he can adequately cope with the variety of tasks and problems in the evaluation instruments.

When the student has mastered a subject and when he receives both objective and subjective evidence of the mastery, there are profound changes in his view of himself and of the outer world.

Perhaps the clearest evidence of affective change is the interest the student develops for the subject he has mastered. He begins to "like" the subject and to desire more of it. To do well in a subject opens up further avenues for exploration of the subject. Conversely, to do poorly in a subject closes an area for further study. The student desires some control over his environment, and mastery of a subject gives him some feeling of control over a part of his environment. Interest in a subject is both a cause of mastery of the subject as well as a result of mastery. Motivation for further learning is one of the more important consequences of mastery.

At a deeper level is the student's self-concept. Each person searches for positive recognition of his worth and he comes to view himself as adequate in those areas where he receives assurance of his competence or success. For a student to view himself in a positive way, he must be given many opportunities to be rewarded. Mastery and its public recognition provide the necessary reassurance and reinforcement to help the student view himself as adequate. It is the opinion of this writer that one of the more positive aids to mental health is frequent and objective indications of self-development. Mastery learning can be one of the more powerful sources of mental health. We are convinced that many of the neurotic symptoms displayed by high school and college students are exacerbated by painful and frustrating experiences in school learning. If 90 percent of the students are given positive indications of adequacy in learning, one might expect such students to need less and less in the way of emotional therapy and psychological help. Contrariwise, frequent indications of failure and learning inadequacy must be accompanied by increased self-doubt on the part of the student and the search for reassurance and adequacy outside the school.

Finally, modern society requires continual learning throughout life. If the schools do not promote adequate learning and reassurance of progress, the student must come to reject learning—both in the school and later life. Mastery learning can give zest to school learning and can develop a lifelong interest in learning. It is this continual learning which should be the major goal of the educational system.

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REFERENCES

Atkinson, R. C., Computerized instruction and the learning process. Technical Report No. 122, Stanford, California. Institute for Mathematical Studies in the Social Sciences, 1967.

Bloom, B. S., Stability and change in human characteristics. New York: John Wiley & Sons, 1964.

Bloom, B. S. (Ed.), Taxonomy of educational objectives: Handbook I, cognitive domain. New York: David McKay Company, 1956.

Bowman, M. J., The new economics of education. *International Journal of Educational Sciences,* 1966, 1:29-46.

Bruner, Jerome, Toward a theory of instruction. Cambridge, Massachusetts: Harvard University Press, 1966.

Carroll, John, A model of school learning. *Teachers College Record,* 1963, 64: 723-733.

Congreve, W. J., Independent learning. *North Central Association Quarterly,* 1965, 40: 222-228.

Dave, R. H., The identification and measurement of environmental process variables that are related to educational achievement. Unpublished doctoral dissertation, University of Chicago, 1963.

Gagné, Robert M., The conditions of learning. New York: Holt, Rinehart, & Winston, 1965.

Glaser, R., Adapting the elementary school curriculum to individual performance. *Proceedings* of the 1967 Invitational Conference on Testing Problems. Princeton, New Jersey: Educational Testing Service, 1968.

Goodlad, J. I. and Anderson, R. H., The nongraded elementary school. New York: Harcourt, Brace & World, 1959.

Hunt, J. McV., Intelligence and experience. New York: Ronald Press Co., 1961.

Husén, T. (Ed.), International study of educational achievement in mathematics: A comparison of twelve countries, Volumes I and II. New York: John Wiley & Sons, 1967.

Morrison, H. C., The practice of teaching in the secondary school. Chicago: University of Chicago Press, 1926.

Schultz, T. W., The economic value of education. New York: Columbia University Press, 1963.

Scriven, Michael, The methodology of evaluation. In Stake, R. (Ed.), *Perspectives of curriculum evaluation.* Chicago: Rand McNally & Co., 1967.

Skinner, B. F., The science of learning and the art of teaching. *Harvard Educational Review,* 1954, 24: 86-97.

Suppes, P., The uses of computers in education. *Scientific American,* 1966, 215: 206-221.

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